Red Bluff – Chico Landing Reach

The pattern of riparian forest succession driven by channel movement and flooding is most fully expressed along the Red Bluff–Chico Landing Reach.

With some exceptions, this reach is unleveed and contains significant and substantial remnants of the Sacramento Valley's riparian forest. The floodplain shows a long history of erosion, deposition, and channel migration. The river has recently meandered in deep alluvial soils throughout this reach.

This reach extends from the Red Bluff Diversion Dam downstream past the towns of Tehama, Los Molinos and Nord (Figure 4-1 and Table 4-1). The reach ends at Chico Landing, a site at the mouth of Big Chico Creek that was once a busy riverboat landing. In addition to supporting a mosaic of riparian vegetation, the river floodplain supports a significant portion of the region's walnut orchards, as well as prunes and row crops.

In its *1989 Plan*, the SB1086 Advisory Council recommended the establishment of a Conservation Area along the Sacramento River. The Conservation Area includes an inner river zone that defines the locations where interested landowners may participate in voluntary riparian habitat conservation and restoration programs administered or coordinated by the Sacramento River Conservation Area Forum. Inner river zone guidelines for this reach have been developed (Chapter 2, pages 2-24 through 2-28), and should be incorporated into site specific planning.. The purpose of the inner river zone guideline is to focus the preservation and reestablishment of a continuous riparian ecosystem on the erosion and flood-prone areas along the Sacramento River in a manner that:

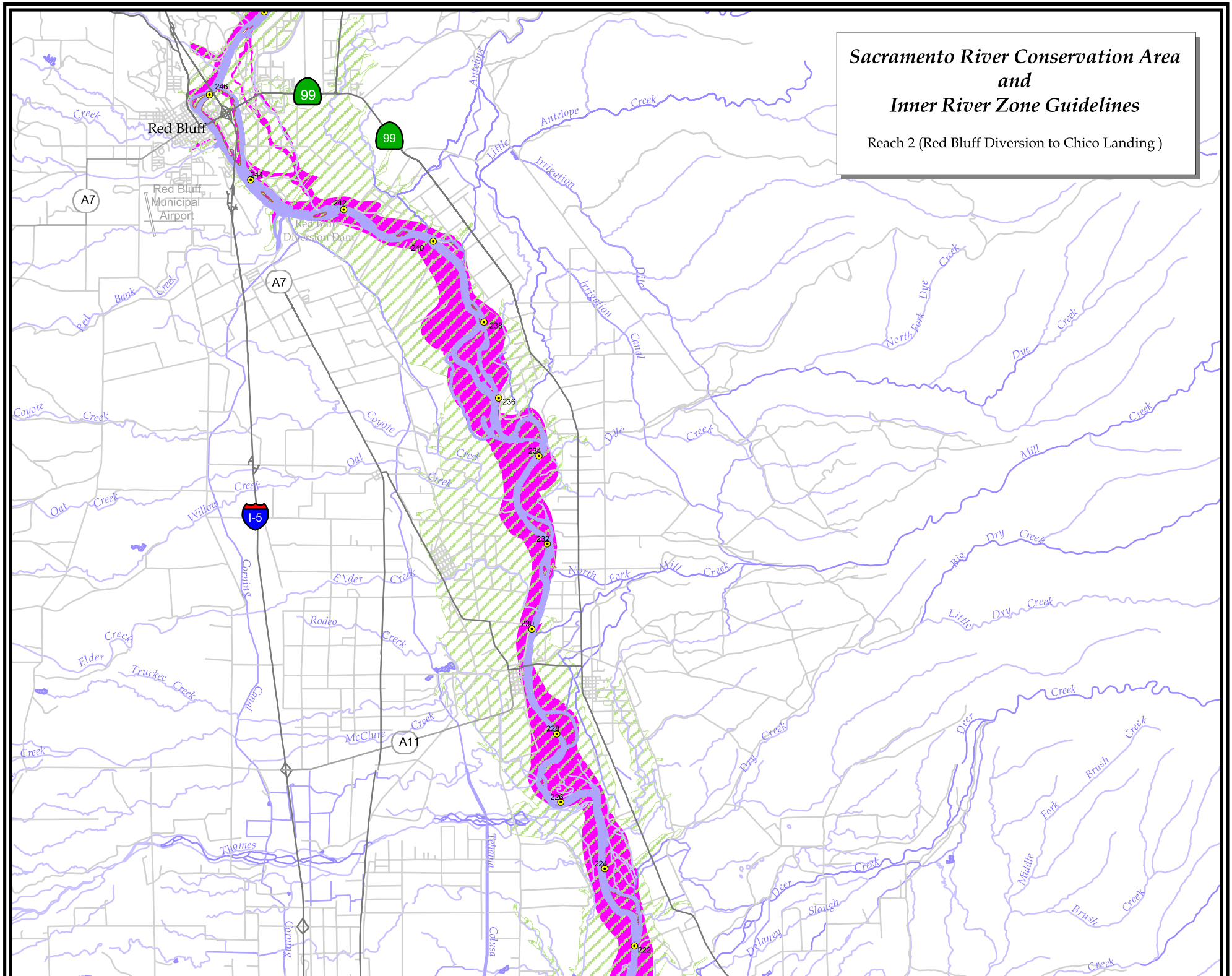
- Uses an ecosystem approach that contributes to recovery of threatened and endangered species and is sustainable by natural processes;
- Uses the most effective and least environmentally damaging techniques to maintain a limited meander where appropriate;
- Operates within the parameters of local, state and federal flood control and bank protection programs;
- Participation by private landowners and affected local entities is voluntary, never mandatory;
- Gives full consideration to landowner, public, and local government concerns;
- Provides for the accurate and accessible information and education that is essential to sound resource management.

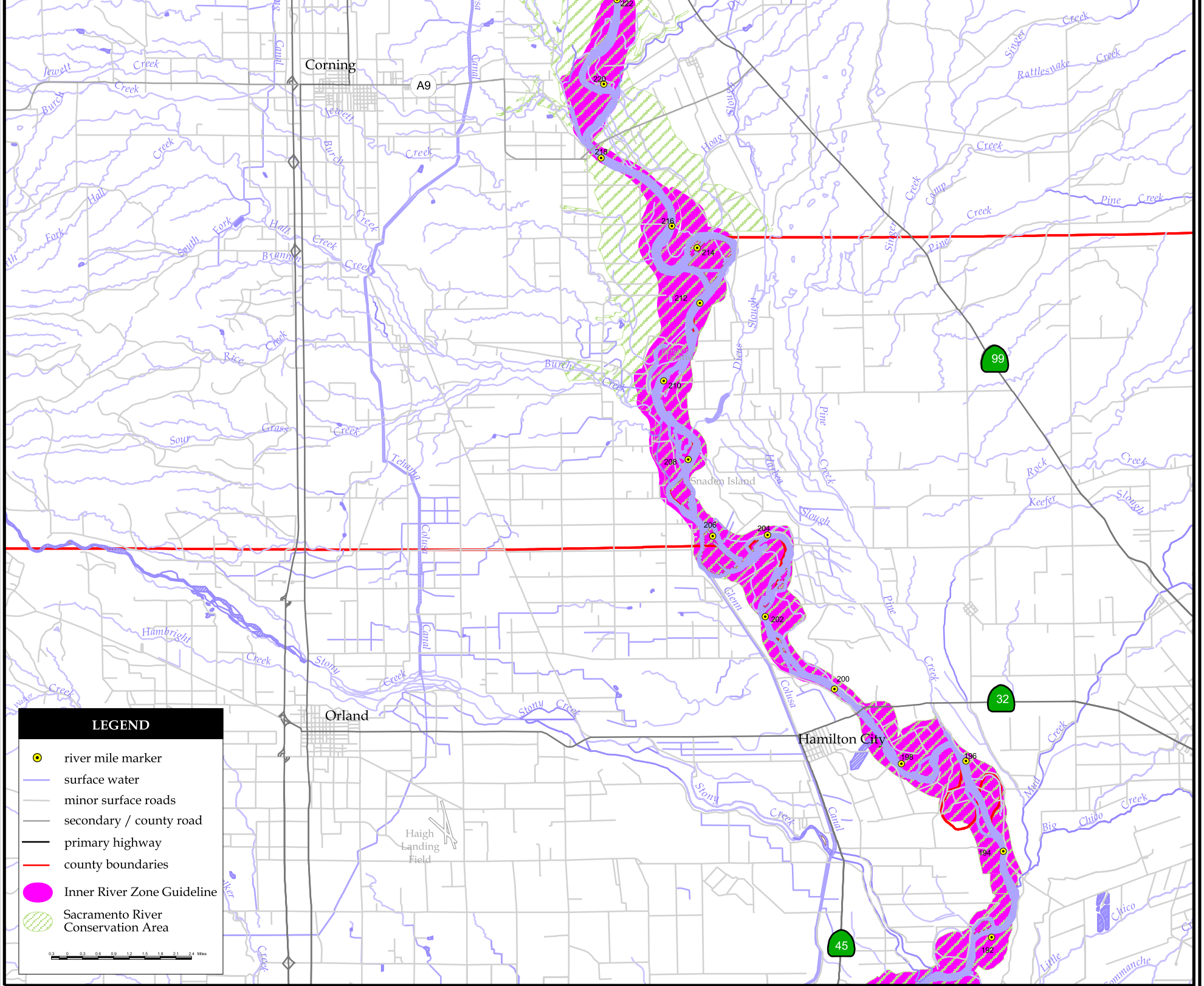
The Red Bluff–Chico Landing portion of the Conservation Area is divided into two sections, split at the southern Tehama County line. In the upper section, the Conservation Area within Shasta and Tehama Counties would include all areas within geologic control, within the 100-year flood-line, and stands of valley oak woodland that are contiguous with this area. In the section south of the Tehama County line, in Butte and Glenn Counties above Chico Landing, the Conservation Area is contiguous with the Inner River Zone Guidelines.

The Inner River Zone Guideline combines the past 100-year meanderbelt with projected erosion locations 50 years in the future.

Table 4-1. *Features of the Red Bluff–Chico Landing Reach*

RIVER MILE	FEATURE	RIVER MILE	FEATURE
243	Red Bluff Diversion Dam	220L	Mouth of China Slough
240L	Mouth of Salt Creek	220L	Mouth of Deer Creek
239L	Blackberry Island	220L	Copeland Bar
239L	Mouth of Craig Creek	219L/R	Woodson Bridge State Recreation Area
237	Todd Island		
236L	Mouth of Butler Slough	218	Woodson Bridge
235R	Sacramento Bar	215R	Mouth of Jewett Creek
235L	Mouth of Antelope Creek	211R	Foster Island
234R	Coyote Creek	210R	Lower Foster Island
234L	Mouth of Dye Creek	209L	Mouth of Dicus Slough
233R	Mouth of Oat Creek	209R	Mouth of Burch Creek
231L	Mouth of North Fork Mill Creek	208L	Mouth of Snaden Slough
230L	Mouth of Mill Creek	207L	Snaden Island
230R	Mouth of Elder Creek	205R	Glenn-Colusa Irrigation District Intake
229R	Tehama		
229	Southern Pacific Rail Road	202R	McIntosh Landing
229L	Los Molinos	199R	Hamilton City
229	Highway 99	199	Gianella Bridge
226R	Mouth of Thomes Creek	198R	Mouth of Dunning Slough
226R	Mouth of McClure Creek	196L	Kusal Slough
225L	Champlin Slough	196L	Mouth of Pine Creek
223L	Mouth of Toomes Creek	195R	Jenny Lind Bend
		194L	Chico Landing
		194L	Bidwell River Park


Sacramento River Conservation Area
and
Inner River Zone Guidelines
Reach 2 (Red Bluff Diversion to Chico Landing)
Red Bluff
Red Bluff Municipal Airport
Red Bluff Diversion Dam
99
A7
A11
I-5
246
244
242
240
238
236
234
232
230
228
226
224
222
Antelope Creek
Little Antelope Creek
Red Bank Creek
Coyote Creek
Oat Creek
Willow Creek
Elder Creek
Rodeo Creek
Truckee Creek
McClure Creek
Thomes Creek
Corning Canal
Tehama Colusa Canal
Irrigation Ditch
North Fork Dye Creek
Dye Creek
Mill Creek
Big Dry Creek
Little Dry Creek
Deer Creek
Middle Fork Brush Creek
Brush Creek
Delaney Slough


Corning
A9
Orland
Hamilton City
Snaden Island
Haigh Landing Field
99
32
45
LEGEND
river mile marker
surface water
minor surface roads
secondary / county road
primary highway
county boundaries
Inner River Zone Guideline
Sacramento River Conservation Area

PHYSICAL SETTING

Geology and Soils

This reach is underlain by sedimentary and volcanic deposits such as the Tehama, Tuscan, and Red Bluff Formations. There are a few outcroppings of these formations within the Conservation Area. The sedimentary Tehama Formation is exposed along near vertical banks in a number of places such as Red Bluff, Tehama, Woodson Bridge and Hamilton City. More recent deposits lie on top of these older formations, including terrace deposits (including the Riverbank and Modesto Formations), paleochannel deposits, alluvial fans, meanderbelt deposits, basin and marsh deposits (DWR, 1994).

The terrace deposits of the Modesto and Riverbank flank the river in stair steps away from channel. These deposits tend to erode at a lower rate than the other young deposits and tend to form higher, more consolidated banks, along the river, referred to as geologic control (Chapter 2). Figure 4-2 illustrates the location of these deposits near Woodson Bridge.

This reach has a high proportion Class I agricultural soils, including the Columbia and Vina loams (Figure 4-3).

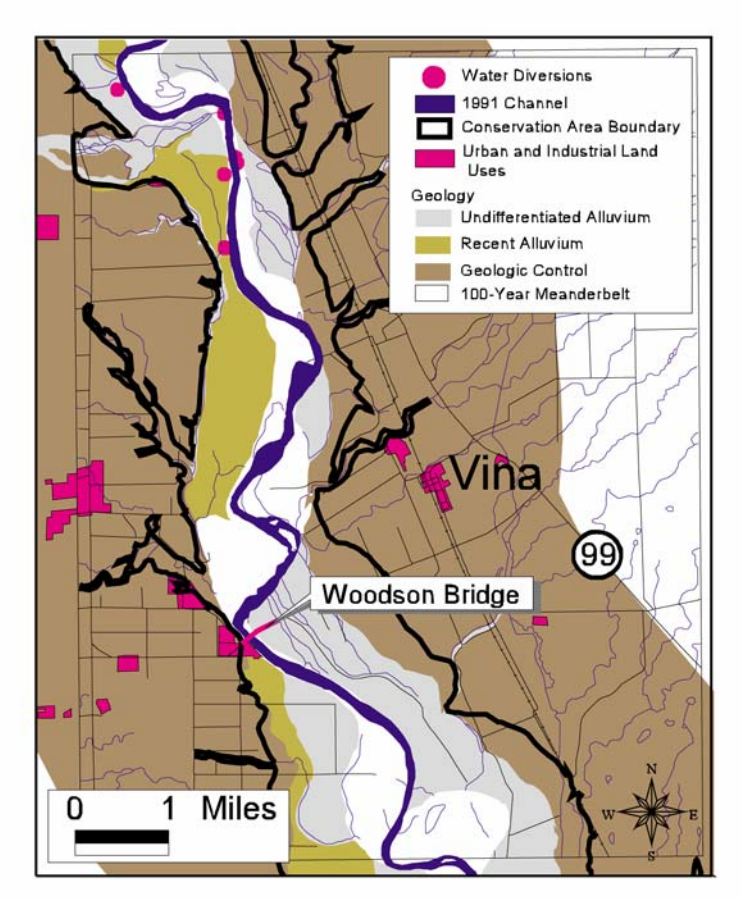


Figure 4-2. *Generalized geologic units and infrastructure (bridges, water diversions, and urban and industrial land uses) along the Sacramento River, RM 214-227 (Vina Quad).*

Channel Movement

The Red Bluff–Chico Landing Reach is a meandering river as described in Chapter 2. An examination of historical channel locations since 1896, as well as such features as oxbow lakes and meander scrolls, shows considerable channel movement. The combination of the channel locations between 1896 and 1991, the "one-hundred year meanderbelt," is approximately 9,200 acres.

The current rate of channel movement in this reach would result in 4,000 to 6,000 acres of erosion and corresponding deposition over the next 50 years (DWR, 1994). New depositional areas will aggrade over time, eventually becoming high terrace lands. Half of the projected erosion will take place within the 100 year meanderbelt, indicating that the river is reworking many areas that were channel bottomless than100 years ago.

Figure 4-3. *Sacramento River corridor near Tehama. Much of the Conservation Area contains productive agricultural areas.*

A 1994 survey of the river calculated the total bank length of this reach (including sloughs, side channels and islands) to be approximately 132 miles; the main channel bank length is approximately 92 miles (DWR, 1994). In 1994, there were 21.5 miles of bank protection installed along the river in this reach, which is currently on the main channel (USFWS, 1994). This is about 16 percent of the total channel and 23 percent of the main channel length.

The Red Bluff–Chico Landing Reach has been divided into eight subreaches (DWR, 1994), based on channel characteristics that include gradient, geometry, underlying rock types, degree of bank erosion, sinuosity, and meander belt width (Table 4-2). Within this reach, short, narrow, and straight subreaches alternate with longer, more sinuous subreaches with higher bank erosion rates. These subreaches are important in that they highlight the areas that are the most active and offer the most potential for ecosystem restoration.

Since 1945, overall channel sinuosity for this reach has decreased. This has been attributed to vegetation removal on meander bends contributing to chute cutoffs. Another possibility could be natural variability in the meander process, implying that sinuosity will increase again over time (HDR, 1993). Although 1945 was the year that Shasta Dam became operational, geomorphologists have not studied whether the altered hydrology has caused this decreased sinuosity.

Table 4-2. Geomorphic subreaches of the Sacramento River between Red Bluff and Chico Landing

River Mile	River Miles	Length (Ml)	Slope	Bank Erosion	Meander Width (feet)	Sinuosity	Channel Shape
A	243-238.5	4.5	.00050	Low	1200	1.0	straight with gravel bars
B	238.5-231	7.4	.00076	High	1400-5400	1.4	sinuous,ana-branching
C	231-228.5	2.5	.00056	Low	700	1.05	straight
D	228.5-218.5	.98	.00054	High	700-5000	1.3	sinuous with gravel bars
E	218.5-216	2.5	.00030	Low	900	1.05	straight
F	216-201	13.4	.00054	High	900-5100	1.5	meandering,ana-branching
G	201-198.5	2.5	.00033	Low	800	1.05	straight
H	198.5-193	5.5	.00052	High	1300-6600	1.5	meandering

Sediment Transport

Observations made during a DWR erosion study between 1986 and 1988 indicate that erosion and deposition rates may be in balance in this reach. Although the incidence of floodplain deposition has decreased, so has the rate of bank erosion (DWR, 1994).

Hydrology and Tributaries

The hydrology of this reach has changed with the advent of the Central Valley Project as described in Chapter 2. The hydrologic influence of the tributaries is quite strong in this reach and is still able to establish and maintain a relatively healthy riparian habitat ecosystem. Each flood event is unique in terms of the quantity and timing of tributary inflow. Major tributaries include Reeds, Antelope, Mill, Elder, Thomes and Deer Creeks. The unregulated tributaries of the Keswick–Red Bluff Reach (notably Cottonwood Creek) also contribute greatly to the hydrologic characteristics and associated health of the riparian system.

The change in hydrology has altered patterns of bank erosion. Overall bank erosion rates have declined since the construction of Shasta Dam, probably due to reductions in peak flow and increased bank protection (DWR 1984, USGS 1977, USACE 1986). Sustained high releases at the dam following a large flood are often necessary to make room in Lake Shasta for runoff from a subsequent large storm. During these releases, banks are saturated and may erode more rapidly than when flows drop to pre-flood levels.

As described in Chapter 1, hydrology plays a critical role in riparian forest establishment and in the successional process. Flooding and the associated deposition create fresh damp substrate for the recruitment of cottonwood seedlings.

This process is instrumental in the formation of the point bars and terraces associated with various age classes of riparian forests and is a driving force behind the meander process.

Flooding regime alteration (Chapter 2) has probably changed the pattern of riparian forest succession in this reach, although the exact mechanisms remain unclear. One mechanism may be related to the rate of erosion and deposition. The reduction in bank erosion suggests an accompanying decrease in point bar formation. This in turn suggests that there could be fewer suitable sites for cottonwood and willow forest regeneration.

Another mechanism may be tied to the frequency with which areas along the river are subjected to flooding and the associated deposition. One result of Shasta's change to Sacramento River hydrology in the Red Bluff–Chico Landing Reach has been that smaller areas are inundated less often. For example, under today's hydrologic conditions, a 2-year flood near Red Bluff is about 70,800 cfs. Prior to the operation of Shasta Dam, a 2-year flood would have been about 110,000 cfs (TNC, 1996). In fact, since construction of the dam, the river has never reached the pre-dam 5-year flood of about 180,000 cfs (HDR, 1993). This means that a smaller area along the river is subjected to the frequency of overbank flooding required for the natural establishment, maturation, and regeneration of forests.

Land Use

About half of the Conservation Area is planted to agricultural crops (Table 4-3). The deep alluvial soils along much of the Sacramento River in this reach are ideal for growing walnuts. Almonds and prunes are also important crops.

Within the inner river zone guideline, about 4,854 acres (30 percent) of the land is in agricultural crops, mostly walnuts, almonds and prunes. A comparison of land use with the eight subreaches shows that orchards are planted most closely to the river channel along the more stable subreaches and that riparian habitat is most developed along the more unstable reaches (Figures 4-4a and 4-4b).

The towns of Gerber and Tehama are within the Conservation Area, while Hamilton City, Los Molinos, and Vina lie just outside. Scattered homes and farmsteads lie within the Conservation Area, although very little development exists within the inner river zone. Four bridges cross the river in this reach—the Southern Pacific Railroad Crossing at Tehama (R.M. 229), the Tehama Bridge (Hwy 99W) at Tehama (R.M. 229), Woodson Bridge (South Avenue) near Corning (RM 218) and Hamilton City Bridge (Hwy 32) near Hamilton City (R.M. 199).

The California Department of Fish and Game lists 29 agricultural water diversions in this reach. The two largest water diversions are the U.S. Bureau of Reclamation Tehama Colusa Canal (RM 243) and the Glenn-Colusa Irrigation District (RM 205.5).

Some of these diversions are stationary, while others are designed to be mobile. All but nine appear to be located on or near geologic control.

There are a number of recreational sites along this reach of the river. These sites include boat launch areas, fishing and swimming areas, and RV parks. The California Department of Parks and Recreation owns three state park areas along the river.

Table 4-3. *Land Use within the Conservation Area, Red Bluff–Chico Landing Reach*

LAND USE CATEGORY	INNER RIVER ZONE GUIDELINE		CONSERVATION AREA	
	Acres	% of Land Surface Area	Acres	% of Land Surface Area
Agriculture	4,854	30%	18,300	53%
Riparian Vegetation	5,662*	35%*	6,864	20%
Upland Vegetation	2,973*	18%*	5,250	15%
Water Surface (excluding main channel)	696	4%	695	2%
Miscellaneous (includes barren wasteland)	1,787	11%	1,932	6%
Urban	321	2%	1,301	4%
Total Land Surface Area	**16,293**	**100%**	**34,107**	**100%**
Channel Surface Area	2,896		2,896	
Total	**19,189**		**37,238**	

*The purpose of DWR land use surveys is to map agricultural crops. **Refer to Appendix D Part 2 for the most accurate riparian vegetation data.** Land use data based on DWR agricultural land use surveys of Shasta, Tehama, Butte, Glenn, Colusa, Sutter, and Yolo Counties (see References).

RIPARIAN VEGETATION

Current Acreage

The survey of riparian resources within this reach is based on 1999 photos; aerial interpretation was performed by the Geographic Information Center at California State University, Chico. The Sacramento River corridor, as defined by the 100-year floodline and contiguous stands of valley oak woodlands, contains more than 9,000 acres of riparian vegetation. Extensive and significant stands of remnant riparian forest are associated with sinuous subreaches (Figure 4-4b) and provide habitat for a variety of sensitive wildlife species including osprey, Swainson's hawk, western yellow billed cuckoo, bank swallow, yellow warbler, yellow breasted chat and northwestern pond turtle.

Table 4-4 lists acreage of riparian vegetation types and other closely related habitats for the area within the inner river zone guideline. The relative amount of total riparian habitat to other land use categories decreases with distance from the active channel.

Approximately 28 acres of valley oak woodland occur outside of but adjacent to the100-year floodplain. Most of the valley oak woodlands for this reach are found outside of the inner river zone, but within the area inundated by a flood with a 2.5 year recurrence interval.

Table 4-4. *Riparian and closely related habitats within the, inner river zone guideline, Red Bluff–Chico Landing Reach*

VEGETATION TYPE	*INNER RIVER ZONE GUIDELINE		*CONSERVATION AREA	
	Acres	% of Land Surface Area	Acres	% of Land Surface Area
Riparian Forests	4,417	27%	5154	10%
Riparian Scrub	3,630	22%	3929	7%
Valley Oak Woodland	44	<1%	115	<1%
Marsh	97	<1%	141	<1%
Blackberry Scrub	13	<1%	46	<1%
Total Riparian Vegetation	**8,201**	**50%**	**9385**	**28%**
Total Land Surface Area	15,904		34,107	
Channel Surface Area	2,896		2,896	
Total	**18,800**		**37,003**	

**(The outer boundary of the Conservation Area in Shasta and Tehama Counties is the approximate 100 year designated floodplain; beginning at the southern Tehama County line, the boundary of the Conservation Area is the same as the Inner River Zone). See Page I-5 for further explanation.* GIC (1997; 2000). Percentages may not total due to rounding.

Current Extent of Habitat Types at Water's Edge

There are several types of banks and habitat types along the river in this reach, including shaded riverine aquatic habitat, cut banks, and sand and gravel bars. Banks in this reach have been recently surveyed by the U.S. Fish and Wildlife Service (USFWS) and the Department of Water Resources (USFWS, 1990; DWR, 1994).

Bank Swallow Nesting Habitat

The USFWS surveyed this reach for bank swallow nesting habitat in 1989, finding .98 miles of active bank swallow nesting habitat and 4.98 miles of inactive habitat. Active sites had bank swallow burrows. Inactive sites did not have burrows, but had the suitable slope, bank height and soil erodibility. In 1994, DWR measured 5.39 miles of suitable bank swallow nesting banks, including both active and inactive sites (Appendix D).

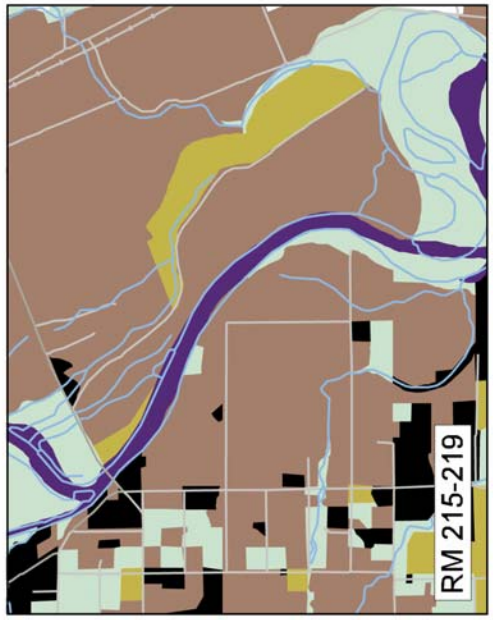
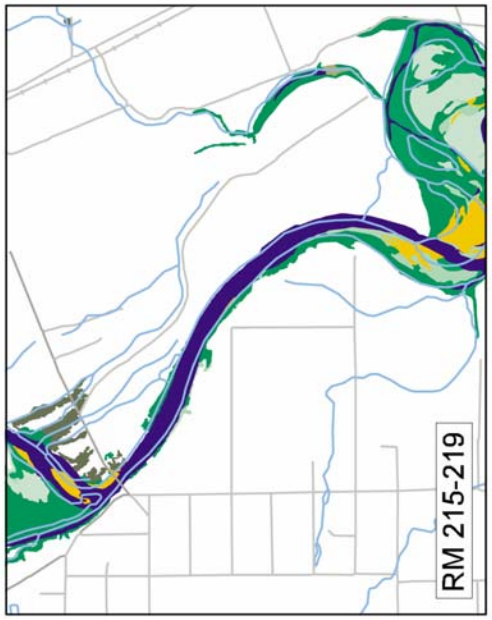


Figure 4-4a. A comparison of land use patterns between an active subreach (left) and a more stable subreach (right). Dark brown areas represent orchards.



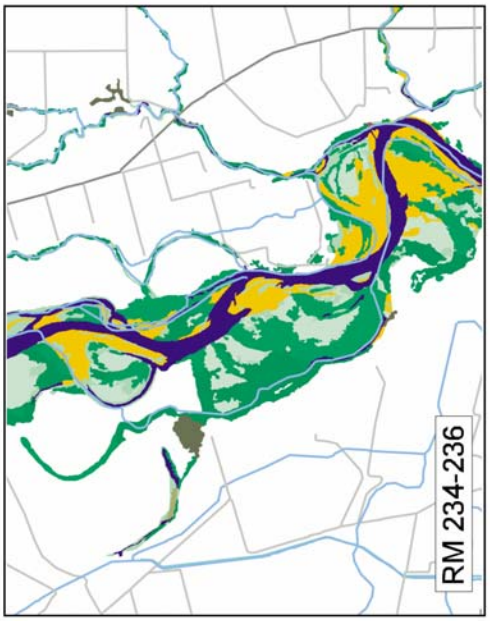


Figure 4-4b. A comparison of riparian vegetation patterns between an active subreach (left) and a more stable subreach (right). Green areas represent successional stages of riparian forest.

The DWR figure represents six percent of the main channel bank length (bank swallow nesting habitat is on the active channel) or four percent of the total channel length.

Shaded Riverine Aquatic Habitat

In 1996 DWR measured 47.41 miles of shaded riverine aquatic habitat in this reach (36 percent of total bank length). Depositional areas accounted for 47.84 miles of bank length (36 percent).

Ownership

Most of the publicly owned land lies within the flood—and erosion—prone lands within the inner river zone guideline (Table 4-5). Some of the publicly owned land that is in agriculture is being converted to riparian habitat, while other portions are leased to agricultural operators to fund restoration efforts (Chapter 7). Private ownership encompasses many land uses including homes, recreational facilities, buildings, pumping plants, flood control structures, agricultural lands, and lands with various types of vegetation.

Table 4-5 *Ownership, Red Bluff–Chico Landing Reach*

OWNERSHIP CATEGORY	INNER RIVER ZONE GUIDELINE		CONSERVATION AREA	
	Acres	% of Land Surface Area	Acres	% of Land Surface Area
Private	9,458	59%	25,309	74%
Public				
Federal	3,429	22%	5,327	16%
State	2,759	17%	3,201	9%
Local District, City, County	258	2%	270	1%
Total (Land Surface Area):	**15,904**	**100%**	**34,107**	**100%**
Channel Surface Area	2,896		2,896	
Total	**18,800**		**37,003**	

DWR Sacramento River GIS (May 2000); DPR (1994). Rounded to nearest 100 acres.

Restoration Strategy

All restoration:

- Uses an ecosystem approach that contributes to recovery of threatened and endangered species and is sustainable by natural processes;
- Uses the most effective and least environmentally damaging bank protection techniques to maintain a limited meander where appropriate;
- Operates within the parameters of local, state and federal flood control and bank protection programs;
- Participation by private landowners and affected local entities is voluntary, never mandatory;
- Gives full consideration to landowner, public, and local government concerns;
- Provides for the accurate and accessible information and education that is essential to sound resource management.

Inner River Zone Guideline

The inner river zone guideline within Reach 2 consists of the area of the 100-year meanderbelt combined with the 50-year erosion projection. When combined, they cover a land surface area of 15,900 acres (Table 4-6). This guideline should be used to focus restoration efforts, and projects should be evaluated according to the established restoration priorities:

1. Preserve intact processes

As the most erosion- and flood-prone land along the river, the Red Bluff–Chico Landing Reach has the greatest potential for the re-establishment of a functional riparian ecosystem. *Protection of land within the inner river zone guidelines, either through landowner participation in voluntary programs or through purchase of these properties or easements by the proposed nonprofit management entity or cooperating public agencies, should receive top priority.*

In the Red Bluff to Chico Landing Reach a 2.5 year interval flood event is associated with inundation of more than 57 percent of the Conservation Area. For some localities, flooding occurs outside of the inner river zone guideline (Figure 4-6). Flood frequency at the 2.5 year recurrence could permit the natural regeneration of riparian forest if the timing of other factors such as seed dispersal, and temperature regime are favorable. Monitoring programs within frequently flooded fallow fields should indicate if this method of "natural restoration" is feasible on a large scale.

Table 4-6. *Comparison of areas within the inner river zone guideline, area inundated in a 2.5 year flood, and Conservation Area, Red Bluff to Chico Landing Reach*

	INNER RIVER ZONE GUIDELINE* (acres)	AREA INUNDATED BY 2.5 YEAR FLOOD[1] (acres)	CONSERVATION AREA (acres)
Land Surface	15,900	19,400	34,107
Channel Surface Area	2,896	2,896	2,896
Total Area	**18,700**	**22,296**	**37,003**

*Refer to Figure 2-12. Acreage rounded to nearest 100 acres
1Estimates based on photography of the Sacramento River at a stage approximating a 2.5 year flood.

2. Allow riparian forests to reach maturity

   There are extensive areas of early successional stages, identified as riparian scrub in Table 4--4, within the inner river zone guideline. These would be allowed to undergo natural succession to a mature forest under inner zone management. Almost 1,800 acres of "herbland" (a cover type of annual and perennial grasses and forbs) also occurs within the inner river zone guideline. *These areas are suitable for establishment of early successional stages and should be allowed to reach maturity under inner zone management.*

   A significant amount of riparian scrub and herbland occurs outside of the inner river zone guideline but within the 2.5 year flood line. These areas may not follow a "typical" successional process but should be allowed to reach a climax forest.

3. Restore physical and successional processes

   As described in the previous chapter, the re-establishment of suitable hydrologic regimes through relocation of berms to higher elevations and the use of regulated flows during seed dispersal of early successional species would facilitate the establishment of riparian species. The majority of the riprap for this reach is in place to prevent the meandering process. Where such bank revetment is no longer needed its removal would restore natural processes and riparian habitat. Any such removal, however, would have to be consistent with the principles outlined at the beginning of this chapter.

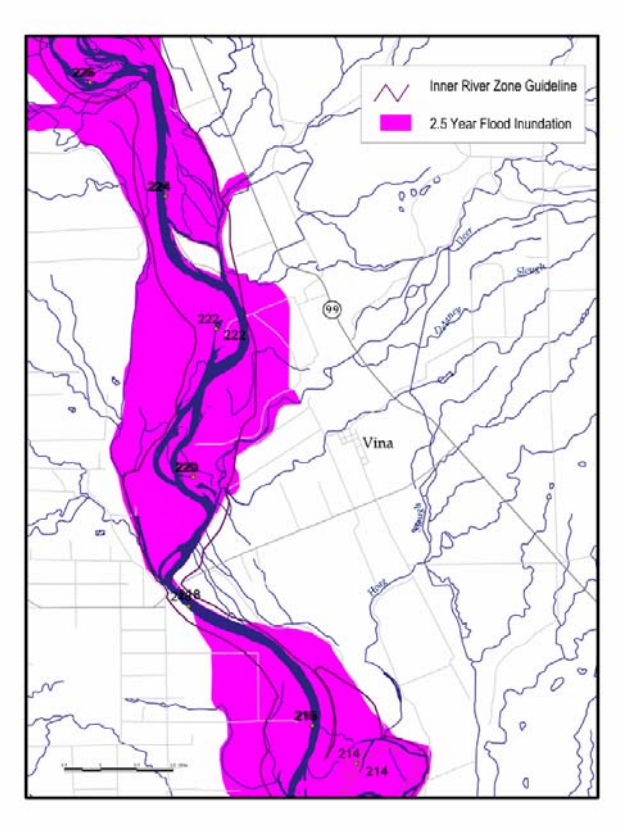


Figure 4-6. *Comparison of inner river zone guideline with area inundated in a 2.5 year flood.*

4. Conduct reforestation activities

Areas outside the frequently flooded areas (defined here as a 2.5 year interval occurrence), but within the Conservation Area, may need active riparian vegetation restoration activities. Because of the lack of a flooding regime on these areas it would be inefficient to attempt to establish early successional or other species which would need a permanent artificial water source. Establishment of valley oak woodland and elderberry savanna (possible valley elderberry longhorn beetle mitigation preserves) is recommended for such areas, because these species are able to withstand drought conditions and perhaps tap into deep water tables. *The establishment of a wide continuous riparian and valley oak woodland corridor should be the first option under the reforestation priority.* Areas adjacent to the corridor should be considered for active restoration after a continuous corridor is established.

The use of "natural restoration" (priority #1) may involve the control of invasive or weedy species. As previously mentioned, establishing a monitoring program within the 2.5 year interval area would help define possible guidelines for the natural restoration within this reach. If native vegetation is out competed by invasive species such as Johnsongrass, star thistle, giant reed, and tree of heaven, a mechanical/herbicide control program or active revegetation plan may be necessary.